In the Claims

1 (currently amended). An apparatus for measuring hydrogen concentration at a temperature above 500°C, comprising an oxide-based proton-conducting solid electrolyte in conjunction with, or in contact with, a self-contained, sealed, metal/hydrogen reference standard comprising a reference material, which is ~~titanium,~~ zirconium ~~or hafnium,~~ or an alloy of ~~titanium,~~ zirconium ~~or hafnium,~~ wherein the zirconium or zirconium alloy contains at least 1010 ppm of oxygen, with a metal to hydrogen atomic ratio such that two phases of the metal/hydrogen solution are present, contained and hermetically sealed within a reference compartment, wherein the reference material is solid and is surrounded by an oxygen-rich layer or comprises an oxygen-rich layer at its surface that prevents reaction between the solid electrolyte and the reference material, and wherein the oxygen activity in the reference material is sufficiently low that the two phases of the metal/hydrogen solution are retained during use of the apparatus to measure hydrogen concentration.

2 (previously presented). The apparatus according to claim 1, wherein the proton conductor is a perovskite.

3 (previously presented). The apparatus according to claim 2, wherein the proton conductor is doped calcium zirconate or doped strontium cerate.

4-5 (canceled).

6 (currently amended). The apparatus according to claim 1, wherein the two-phase area is that of ~~α-titanium/β-titanium,~~ α-zirconium/β-zirconium[[,]] or β-zirconium/δ-zirconium~~, or α-hafnium/δ-hafnium~~.

7-8 (canceled).

9 (previously presented). The apparatus according to claim 1, wherein the oxygen-rich layer on the solid reference material either originates from the production process of the metal or is generated subsequently by means of a chemical reaction.

10 (previously presented). The apparatus according to claim 9, wherein the chemical reaction to generate an oxygen rich layer on the particles of a solid reference material comprises heating the metal of the reference system or the metal/hydrogen reference mixture in the presence of a metal oxide.

11 (previously presented). The apparatus according to claim 1, wherein the solid electrolyte is coated with a catalyst at the point of contact with the electrode.

12 (previously presented). The apparatus according to claim 11, wherein the catalytic coating is platinum.

13 (previously presented). The apparatus according to claim 1, wherein the reference standard is sealed with a sealing material that is chemically stable in a hydrogen containing gas at elevated temperatures.

14 (previously presented). The apparatus according to claim 13, wherein the sealing material is a silicon-free oxide glass that comprises one or more of the oxides of aluminum, barium, boron, calcium and/or magnesium.

15 (previously presented). The apparatus according to claim 13, wherein an inert packing material is used as a separator between the reference material and the sealing material.

16 (previously presented). The apparatus according to claim 15, wherein the inert packing material is calcium zirconate or yttrium oxide.

17 (previously presented). The apparatus according to claim 1, wherein the reference standard is created in two steps by, firstly, hermetically sealing the metal into the reference compartment and, secondly, passing hydrogen electrochemically through the solid electrolyte to form the metal/hydrogen reference material.

18 (previously presented). The apparatus according to claim 1, wherein the metal/hydrogen reference standard is generated in one step, by heating the metal in the presence of a hydrogen containing gas while simultaneously forming a seal to close the reference compartment.

19 (previously presented). The apparatus according to claim 1, wherein the sensor, after preparation and prior to use, is preconditioned with a humidified gas of low hydrogen content at elevated temperatures.

20 (previously presented). The apparatus according to claim 19, wherein the preconditioning is performed in a humidified mixture of 1% hydrogen or less in argon at 700°C or more for 15 min or more.

21 (currently amended). A method for measuring hydrogen concentration comprising the steps of: providing a probe comprising an oxygen-based proton-conducting solid electrolyte in conjunction with, or in contact with, a sealed, or self-contained, metal/hydrogen reference standard comprising a reference material, which is ~~titanium,~~ zirconium ~~or hafnium,~~ or an alloy of ~~titanium,~~ zirconium ~~or hafnium~~, wherein the zirconium or zirconium alloy contains at least 1010 ppm of oxygen, with a metal to hydrogen atomic ratio such that two phases of the metal/hydrogen solution are present, contained and hermetically sealed within a reference compartment, wherein the metal/hydrogen mixture is solid and is surrounded by an oxygen-rich layer or comprises an oxygen-rich layer at its surface that prevents reaction between the solid electrolyte and the reference material, and wherein the oxygen activity in the reference material is sufficiently low that the two phases of the metal/hydrogen solution are retained during use of the apparatus to measure hydrogen concentration; bringing the electrolyte into contact with a hydrogen concentration to be measured, at

a temperature above 500°C; and measuring a voltage generated across the electrolyte between the hydrogen concentration and the reference standard.

22-28 (canceled).

29 (previously presented). The apparatus according to claim 14, wherein the sealing material has a melting temperature below 1200°C.

30-31 (canceled).

32 (new). An apparatus for measuring hydrogen concentration at a temperature above 500°C, comprising an oxide-based proton-conducting solid electrolyte in conjunction with, or in contact with, a self-contained, sealed, metal/hydrogen reference standard comprising a reference material, which is titanium or hafnium, or an alloy of titanium or hafnium, with a metal to hydrogen atomic ratio such that two phases of the metal/hydrogen solution are present, contained and hermetically sealed within a reference compartment, wherein the reference material is solid and is surrounded by an oxygen-rich layer or comprises an oxygen-rich layer at its surface that prevents reaction between the solid electrolyte and the reference material, and wherein the oxygen activity in the reference material is sufficiently low that the two phases of the metal/hydrogen solution are retained during use of the apparatus to measure hydrogen concentration.

33 (new). The apparatus according to claim 32, wherein the titanium or titanium alloy contains more than 1780 ppm of oxygen.

34 (new). The apparatus according to claim 32, wherein the proton conductor is a perovskite.

35 (new). The apparatus according to claim 34, wherein the proton conductor is doped calcium zirconate or doped strontium cerate.

36 (new). The apparatus according to claim 32, wherein the two-phase area is that of α-titanium/β-titanium or α-hafnium/δ-hafnium.

37 (new). A method for measuring hydrogen concentration comprising the steps of: providing a probe comprising an oxygen-based proton-conducting solid electrolyte in conjunction with, or in contact with, a sealed, or self-contained, metal/hydrogen reference standard comprising a reference material, which is titanium or hafnium, or an alloy of titanium or hafnium, with a metal to hydrogen atomic ratio such that two phases of the metal/hydrogen solution are present, contained and hermetically sealed within a reference compartment, wherein the metal/hydrogen mixture is solid and is surrounded by an oxygen-rich layer or comprises an oxygen-rich layer at its surface that prevents reaction between the solid electrolyte and the reference material, and wherein the oxygen activity in the reference material is sufficiently low that the two phases of the metal/hydrogen solution are retained during use of the apparatus to measure hydrogen concentration; bringing the electrolyte into contact with a hydrogen concentration to be measured, at a temperature above 500°C; and measuring a voltage generated across the electrolyte between the hydrogen concentration and the reference standard.